4

Air Monitoring

Paula J. Tate
Paris E. Althouse

Introduction

Air surveillance monitoring is performed to evaluate compliance with local, state, and federal regulations and to ensure that human health and the environment are protected from hazardous and radioactive air emissions. LLNL complies with local, state, and federal environmental air quality laws and DOE regulations, including 40 CFR 61, the National Emissions Standards for Hazardous Air Pollutants (NESHAPs) section of the Clean Air Act, and DOE Orders 5400.1, *General Environmental Protection Program,* and 5400.5, *Radiation Protection of the Public and the Environment*. The *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* (U.S. Department of Energy 1991) provides the guidance for implementing DOE Orders 5400.1 and 5400.5. Other laws governing air quality include 22 CCR 67264.700 and 66265.710, Environmental and Compliance Monitoring, and the California Air Toxics "Hot Spots" Information and Assessment Act of 1987 (AB2588). In general, the constituents that LLNL analyzes (in order to determine environmental impact) are at levels far below the regulatory standards.

LLNL conducts surveillance monitoring of ambient air to determine if airborne radionuclides or hazardous materials are being released by Laboratory operations, what the concentrations are, and what the trends are in the LLNL environs. In the air monitoring program, particles are collected on filters and vapor is chemically trapped on a collection medium. Concentrations of various airborne radionuclides (including particles and tritiated water vapor) and beryllium are measured at the Livermore site, Site 300, at off-site locations throughout the Livermore Valley, and at an off-site location in Tracy. In addition, some point sources and diffuse, or nonpoint sources, are monitored to fulfill NESHAPs requirements (Gallegos and Biermann 1997).

Methods

For air surveillance monitoring, two networks monitor the air particulates in the environs of the Livermore site, and one network monitors particulates in the environs of Site 300, including one sampler in the city of Tracy. All these networks use continuously operating, high volume samplers located as shown in **Figures 4-1, 4-2,** and **4-3**.

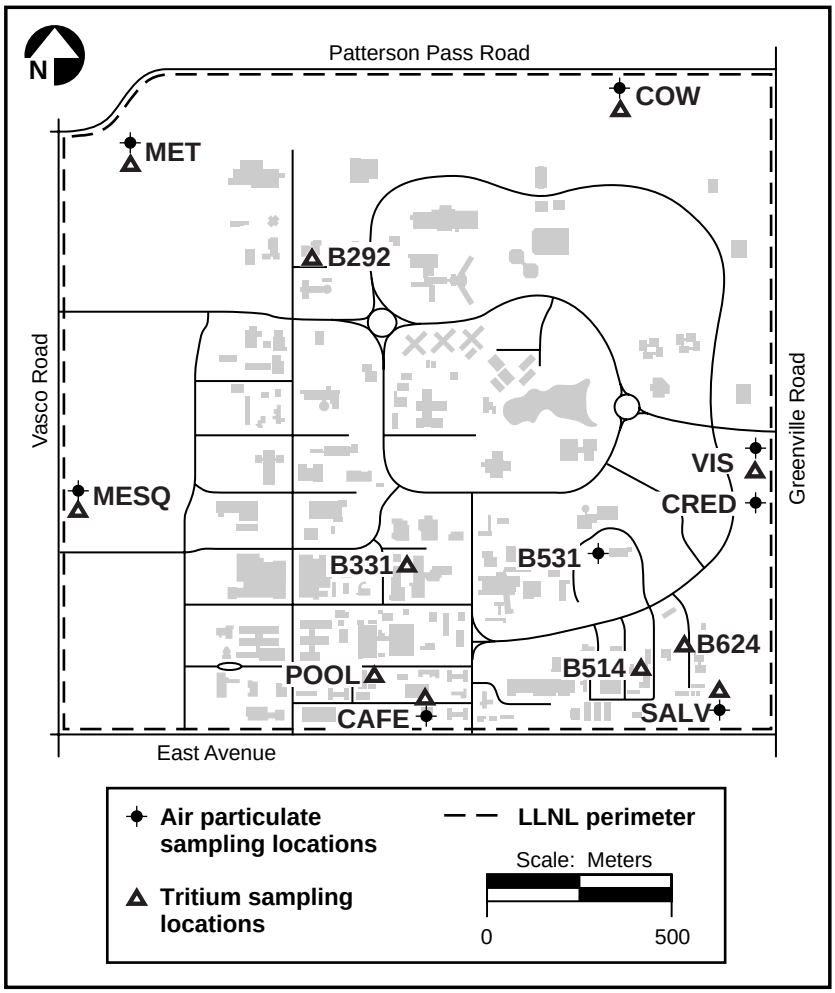

Figure 4-1. Air particulate and tritium sampling locations, Livermore site, 1996.

The Livermore site perimeter air particulate network consists of six samplers at the perimeter and two at areas of special interest (B531, CRED). The Livermore Valley network consists of samplers located in all compass directions. For the purposes of data analysis, four samplers located in the least prevalent wind directions (FCC, FIRE, HOSP, and RRCH) are considered to be upwind or representative of background locations and four samplers located in the most prevalent downwind directions (PATT, ZON7, TANK, and ALTA) are considered most likely to be impacted by Laboratory operations. An additional sampler is located in an area of special interest, the Livermore Water Reclamation Plant (LWRP), because of a plutonium release to the sanitary sewer system in 1967 with subsequent soil contamination and potential resuspension (see Results section below). These air samplers are positioned to provide reasonable probability that any significant concentration of radioactive particulate or beryllium effluents from LLNL operations will be detected should it occur. The geographical details of the

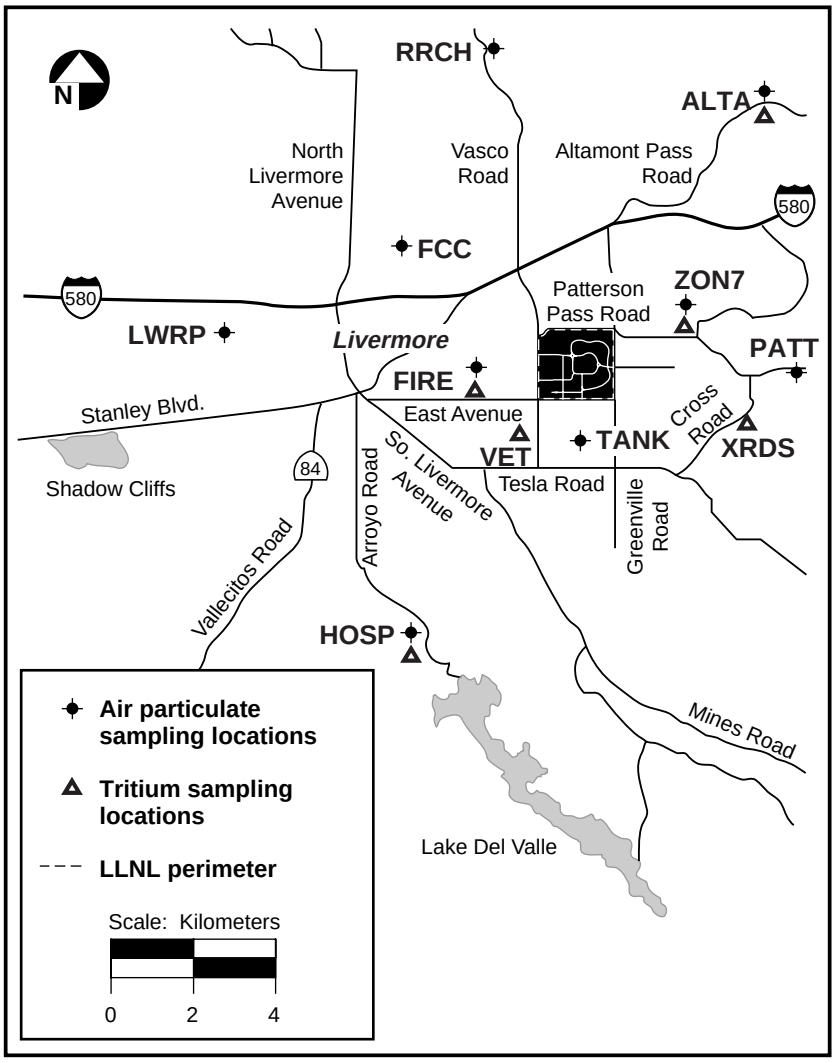

Figure 4-2. Air particulate and tritium sampling locations, Livermore Valley, 1996.

particulate sampling locations are outlined in a procedure in Appendix A of the *Environmental Monitoring Plan* (Tate et al. 1995).

LLNL also maintains 11 continuously operating airborne tritium samplers on the Livermore site (**Figure 4-1**) and 6 samplers in the Livermore Valley (**Figure 4-2**). In November 1996, one tritiated water vapor sampling site (HOSP) was added to the network. This site is located upwind. Four of the Livermore site locations (B331, B292, B514, and B624) monitor diffuse tritium emissions. The tritium sample locations are detailed in Appendix A of the *Environmental Monitoring Plan* (Tate et al. 1995).

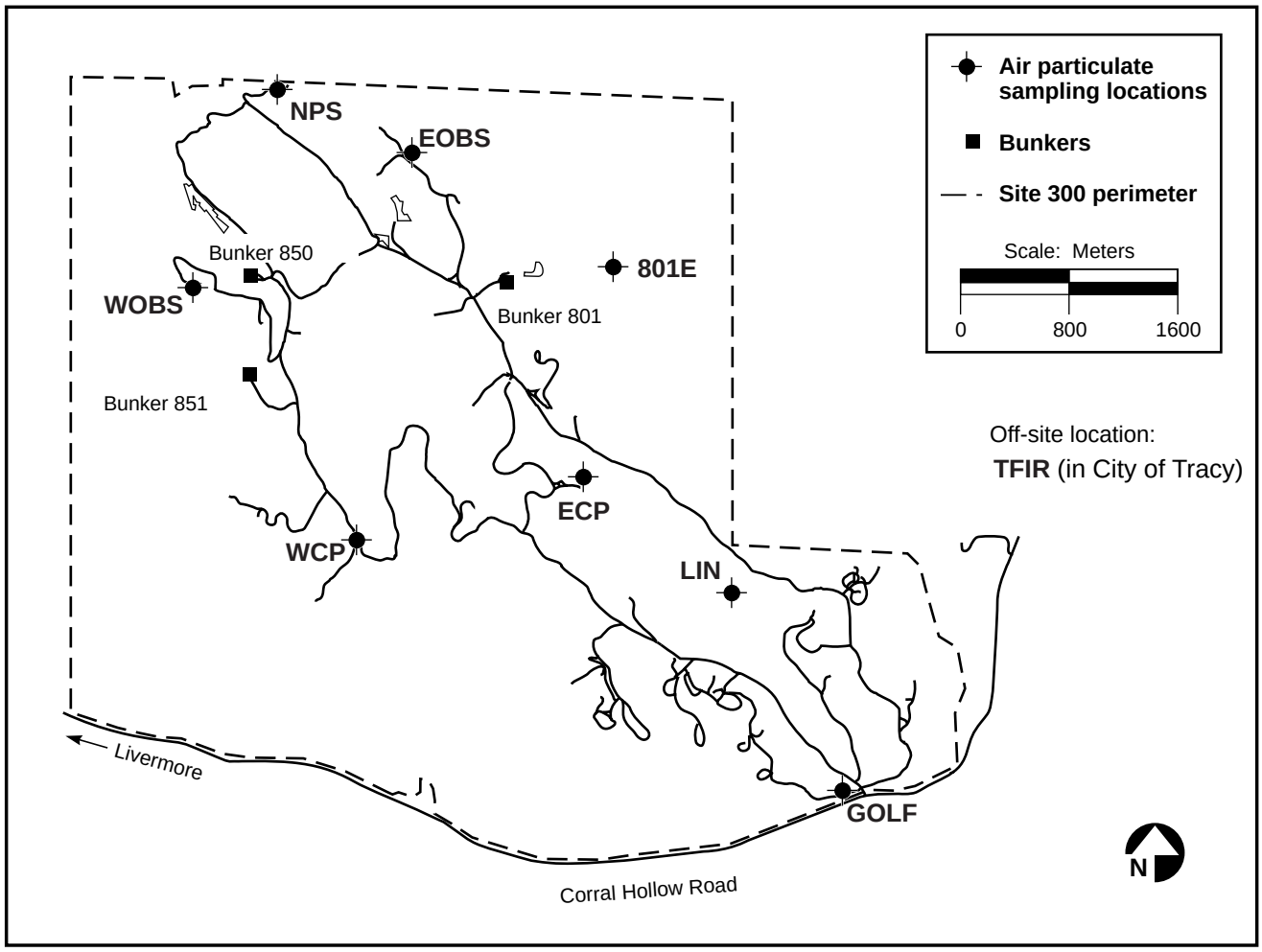

Figure 4-3. Air particulate sampling locations, Site 300, 1996.

Particulate filters are changed each week at all locations, and tritium samples are changed every two weeks. Duplicate quality control samplers are operated for 2 months in parallel with the permanent sampler at a given site, and samples are analyzed to confirm results.

As outlined in the *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* (U.S. Department of Energy 1991), gross alpha and gross beta air filter results are used as trend indicators; specific radionuclide analysis is done for plutonium, uranium, and gamma emitters. All analytical results are reported as a measured concentration per volume of air, or at the minimum detection limit (MDL) when no activity is detected. In all cases, the MDL is more than adequate for demonstrating compliance with the pertinent regulatory requirements for radionuclides that may be or are present in the air sample and for evaluating LLNL-induced environmental impacts. Particle size distributions are not determined because the

estimated effective dose equivalent to the maximally exposed individual is well below the 0.01 mSv (1 mrem) allowable limit as discussed in the above mentioned *Environmental Regulatory Guide.* Further details of the surveillance monitoring methods are included in Volume 2, Chapter 4.

Results

This section discusses the air monitoring results at the Livermore site and at Site 300.

Livermore Site

Airborne Radioactivity

Table 4-1 summarizes the monthly gross alpha and gross beta results for the LLNL perimeter, Livermore Valley, and Site 300 sampling locations. Medians, interquartile ranges (IQR), and maximum values for each network are included. (See Volume 2, Tables 4-1 and 4-2 for detailed location results for all networks for gross alpha and gross beta concentrations.) The monthly median gross alpha and gross beta concentrations are plotted in **Figures 4-4** and **4-5**, respectively. The gross beta results follow a similar pattern to previous years' data.

The gross alpha data are much more variable because of the nature of the standard analytical method capabilities, and most of the data are at or below the minimum detection limit of the method.

Typical gross alpha activity (median value) for the LLNL perimeter network is 6.3×10^{-12} Bq / mL (1.7×10^{-22} Ci / mL); for the upwind Livermore Valley stations the value is 1.4×10^{-12} Bq / mL (3.7×10^{-23} Ci / mL); and for the downwind Livermore Valley stations the value is 1.2×10^{-11} Bq / mL (3.2×10^{-22} Ci / mL). Negative values occur when the activity of the analytical background filters is higher than the activity on the filters being analyzed. Typical gross beta activity (median value) for the LLNL perimeter is 3.9×10^{-10} Bq / mL (1.1×10^{-20} Ci / mL); for the upwind Livermore Valley stations the value is 3.7×10^{-10} Bq / mL (1.0×10^{-20} Ci / mL); and for the downwind Livermore stations the value is 3.7×10^{-10} Bq / mL (1.0×10^{-20} Ci / mL). These values are similar to those obtained from previous monitoring data during the past several years. The primary sources of the alpha and beta activities are the naturally occurring radioisotopes of uranium and thorium, and any residual fallout from atmospheric weapons testing and the Chernobyl reactor accident in 1986.

Table 4-1. Gross alpha and gross beta in air particulate samples summarized by month, 1996.[a]

	Gross alpha (10^{-12} Bq/mL)			Gross beta (10^{-12} Bq/mL)		
	Median	Interquartile range	Maximum	Median	Interquartile range	Maximum
LLNL perimeter						
Jan	1.63	49.8	68.0	252	525	996
Feb	3.52	49.0	109	381	487	794
Mar	4.32	39.1	65.8	357	207	574
Apr	–4.64	30.8	42.6	491	157	981
May	28.0	70.4	192	400	417	846
June	0.117	56.6	85.6	258	226	693
July	13.7	55.5	145	423	152	644
Aug	27.8	46.9	145	424	146	838
Sept	17.7	59.3	112	424	181	855
Oct	–5.03	66.6	58.8	418	236	1110
Nov	–8.80	60.5	242	426	518	1270
Dec	2.30	35.6	92.8	187	150	712
Livermore Valley upwind						
Jan	–14.4	44.6	37.9	259	515	923
Feb	2.89	44.0	85.5	284	470	769
Mar	–7.29	39.5	95.8	331	80.7	510
Apr	–4.44	14.2	44.4	466	225	685
May	44.4	51.2	109	468	340	775
June	9.82	46.0	123	279	219	655
July	21.7	55.2	129	368	122	736
Aug	16.2	36.6	99.5	437	192	775
Sept	–7.38	59.9	49.8	363	269	706
Oct	–9.91	31.1	112	450	401	1060
Nov	27.9	57.6	123	428	566	2080
Dec	–1.16	43.4	102	195	82.5	622

Table 4-1. Gross alpha and gross beta in air particulate samples summarized by month, 1996[a] (concluded).

	Gross alpha (10^{-12} Bq/mL)			Gross beta (10^{-12} Bq/mL)		
	Median	Interquartile range	Maximum	Median	Interquartile range	Maximum
Livermore Valley downwind						
Jan	2.10	44.4	93.6	242	478	780
Feb	15.1	39.4	74.7	428	440	829
Mar	13.6	37.0	93.2	343	135	585
Apr	13.5	48.8	47.5	429	209	778
May	20.0	36.0	66.7	456	358	858
June	9.12	32.1	97.0	245	241	532
July	12.4	79.5	119	355	200	707
Aug	29.8	36.1	89.3	418	219	710
Sept	36.2	45.9	125	435	141	635
Oct	13.6	72.7	96.4	468	381	1070
Nov	0.930	41.2	73.1	302	616	1670
Dec	7.75	58.7	131	232	95.7	546
Site 300						
Jan	0.719	55.0	72.7	267	271	882
Feb	15.4	48.2	124	293	433	1070
Mar	17.1	37.9	105	357	217	663
Apr	12.5	52.5	106	399	245	745
May	40.8	51.1	139	559	330	852
June	–7.17	45.7	119	356	266	742
July	–5.69	60.9	139	458	175	734
Aug	10.9	53.0	134	451	324	908
Sept	14.3	48.7	111	411	355	916
Oct	2.19	46.7	114	430	509	1110
Nov	19.2	85.1	137	343	658	1860
Dec	–3.38	39.6	82.8	214	133	385

[a] Negative values indicate that at least half of the samples had activity of the background greater than that of the sample.

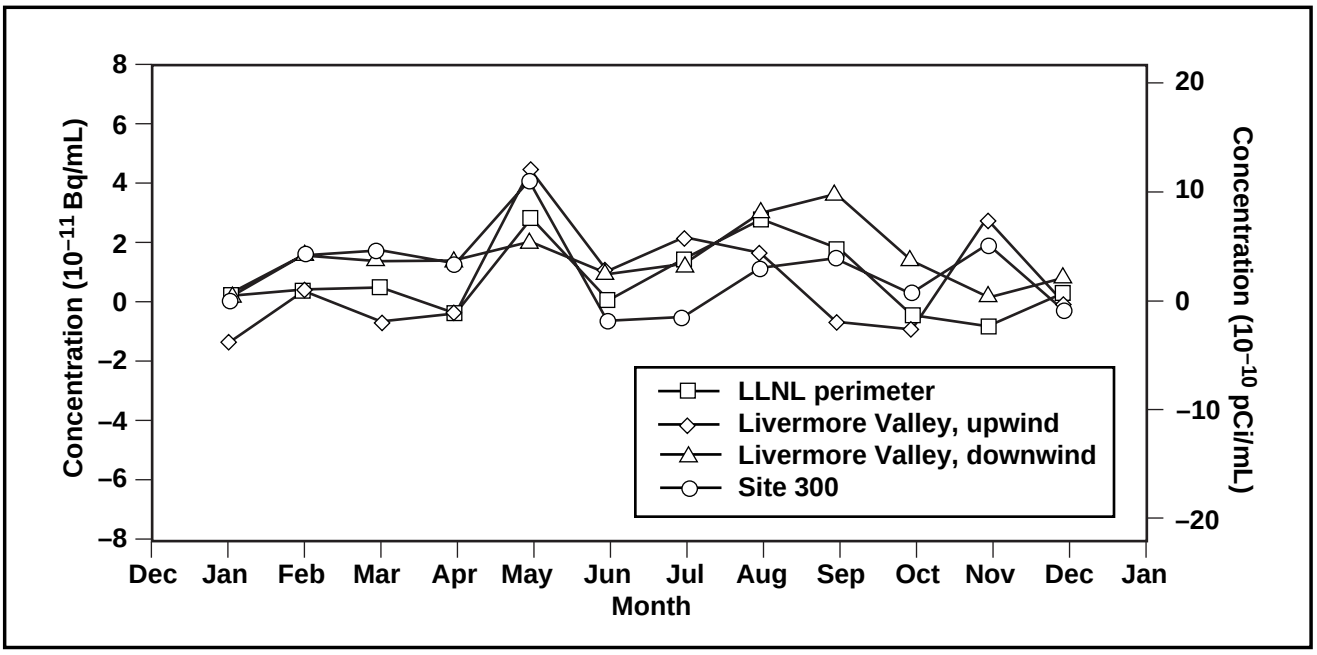

Figure 4-4. Monthly median gross alpha concentrations in particulate air samples from LLNL perimeter, Livermore Valley, and Site 300 sampling locations, 1996.

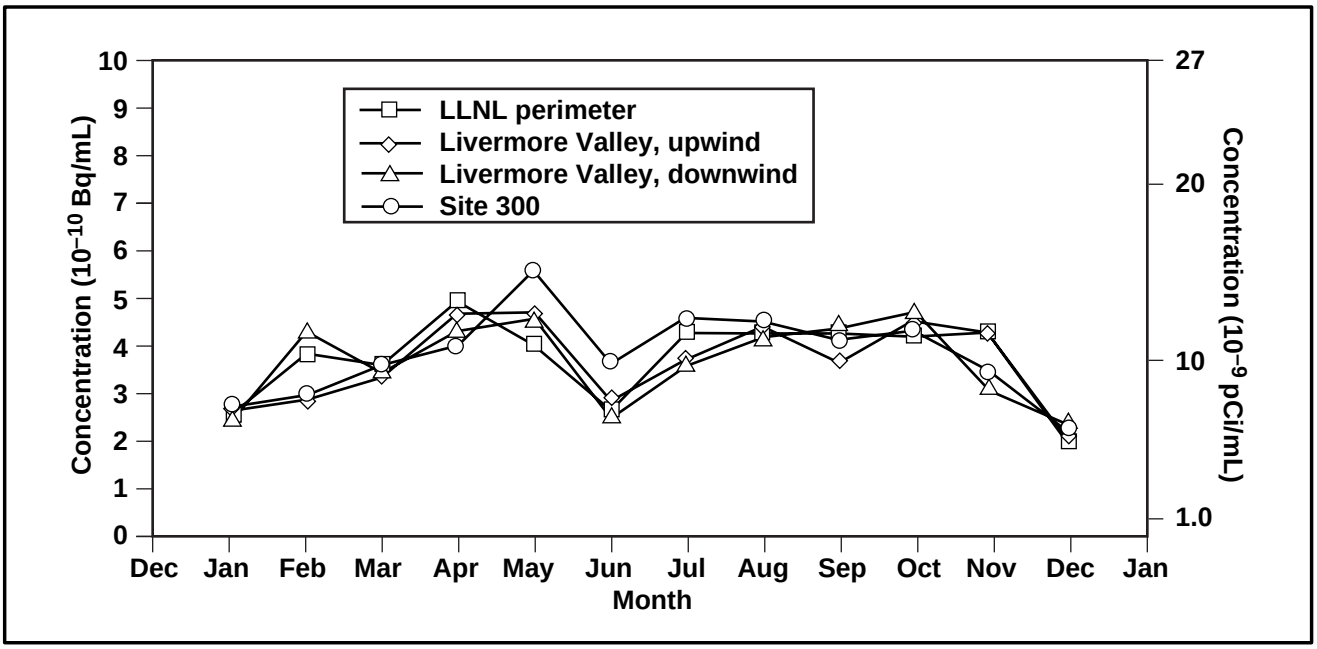

Figure 4-5. Monthly median gross beta concentrations in particulate air samples from LLNL perimeter, Livermore Valley, and Site 300 sampling locations, 1996.

Gamma-emitting radionuclide concentrations in air that contribute to the activity in the Livermore site perimeter samples are summarized in **Table 4-2**. (See Volume 2, Table 4-4 for monthly gamma data.) Of the nuclides tabulated, ^{7}Be, ^{40}K, ^{226}Ra, ^{228}Ra, and ^{228}Th occur naturally. The primary source of ^{137}Cs is long-term global fallout and fallout resuspension.

Table 4-2. Gamma activity in air particulate samples, Livermore site perimeter and Site 300, 1996.

	^{7}Be	^{40}K	^{137}Cs	^{22}Na	^{226}Ra	^{228}Ra	^{228}Th
	(10^{-9} Bq/mL)	(10^{-12} Bq/mL)					
Livermore perimeter							
Median	4.9	<6.3	<0.2	<0.3	<0.6	<1.4	<0.7
Interquartile range	1.6	—[a]	—[a]	—[a]	—[a]	—[a]	—[a]
Maximum	6.8	29.4	<0.3	0.9	<2.8	2.9	1.8
Median fraction of DCG[b]	3.3×10^{-6}	$<1.9 \times 10^{-7}$	$<1.3 \times 10^{-8}$	$<7.8 \times 10^{-9}$	$<1.5 \times 10^{-5}$	$<1.2 \times 10^{-5}$	$<4.6 \times 10^{-4}$
Site 300							
Median	5.8	<4.8	<0.1	0.6	<0.4	<0.9	<0.4
Interquartile range	3.7	—[a]	—[a]	—[a]	—[a]	—[a]	—[a]
Maximum	7.4	14.8	<0.3	1.0	<1.5	<1.7	<1.2
Median fraction of DCG	3.9×10^{-6}	$<1.4 \times 10^{-7}$	$<1.0 \times 10^{-8}$	$<1.6 \times 10^{-8}$	$<9.7 \times 10^{-6}$	$<7.8 \times 10^{-6}$	$<2.8 \times 10^{-4}$
DCG (Bq/mL)	1.5×10^{-3}	3.3×10^{-5}	1.5×10^{-5}	3.7×10^{-5}	3.7×10^{-8}	1.1×10^{-7}	1.5×10^{-9}

a No measure of dispersion calculated. See Chapter 13, Quality Assurance.

b Derived Concentration Guide.

In addition to providing baseline data on global fallout, analysis of these radionuclides enables LLNL to monitor the containment of the small inventories of mixed fission products and radiochemical tracers used at LLNL. The Derived Concentration Guides (DCGs) for these radionuclides are also shown in **Table 4-2**. For air, DCGs specify the concentrations of radionuclides that could be inhaled continuously 365 days a year without exceeding the DOE primary radiation protection standard for the public, which is 1 mSv / y (100 mrem / y) effective dose equivalent (DOE Order 5400.5). (Chapter 12 on Radiological Dose Assessment provides an explanation of this and other units of dose.) Finally, the fraction of the DCGs is presented. These values demonstrate that levels of gamma activity present in air at the Livermore site perimeter are far below the DCGs. Air monitoring data are compared to the DOE DCG in 5400.5, and compliance with the EPA 10 mrem standard (40 CFR 61) is demonstrated by modeling.

Table 4-3 shows the median, IQR, maximum, and median fraction of DCG for concentration of plutonium on air filter samples collected in the Livermore Valley. (See Volume 2, Table 4-6 for monthly data.) The highest off-site median concentration of ^{239}Pu occurred at the Livermore Water Reclamation Plant (LWRP). Soils near the LWRP contain some detectable plutonium, principally resulting from sludge-spreading operations following an estimated 1.2×10^9 Bq (32 mCi) release to the sewer in 1967 (see Chapter 9, Soil and Sediment Monitoring). Resuspension of these soils probably accounts for the slightly higher median ^{239}Pu in air concentrations observed. However, the median observed value is <0.00003 of the DCG.

Table 4-3. Plutonium activity in air particulate samples (in 10^{-15} Bq/mL), 1996.

Sampling location[a]	Median	Interquartile range	Maximum	Median fraction of DCG[b]
Livermore Valley downwind locations				
ALTA	2.7	4.9	9.6	3.6×10^{-6}
PATT	0.38	9.8	28	5.1×10^{-7}
TANK	0.14	4.7	10	1.8×10^{-7}
ZON7	–4.7	15.4	12	-6.4×10^{-6}
Livermore Valley upwind locations				
FCC	3.1	7.7	16	4.2×10^{-6}
FIRE	8.4	13	29	1.1×10^{-5}
HOSP	6.6	6.0	27	8.9×10^{-6}
RRCH	9.6	8.5	17	1.3×10^{-5}
Special interest				
LWRP	18	26	51	2.4×10^{-5}
LLNL perimeter				
CAFE	24	22	70	3.2×10^{-5}
COW	21	20	43	2.8×10^{-5}
MESQ	15	18	41	2.1×10^{-5}
MET	14	8.1	36	1.9×10^{-5}
SALV	18	9.4	150	2.4×10^{-5}
VIS	24	22	84	3.2×10^{-5}
Diffuse on-site sources				
B531	130	340	940	1.7×10^{-4}
CRED	11	14	34	1.5×10^{-5}
Site 300	3.7	2.8	10	4.9×10^{-6}
Tracy	2.2	4.7	15	2.9×10^{-6}

[a] See **Figures 4-1, 4-2,** and **4-3** for sampling locations.

[b] Derived Concentration Guide = 7.4×10^{-10} Bq/mL (2×10^{-14} μCi/mL) for ^{239}Pu activity in air.

Table 4-3 also shows the concentrations of airborne ^{239}Pu on air filters from the LLNL perimeter locations. (See Volume 2, Table 4-7 for the detailed location monthly data.) The highest concentration was registered at location SALV in September 1996; the concentration value is reported as 1.5×10^{-13} Bq / mL (4.1×10^{-24} Ci / mL), which represents 0.0002 of the DCG. This concentration may be due to the construction activities in the area, which included significant grading and dirt movement, thereby increasing the resuspension probability. The median concentration at location SALV is 1.8×10^{-14} Bq / mL (4.9×10^{-25} Ci / mL), which is just slightly lower than the previous year.

Figure 4-6 shows the annual median concentrations of ^{239}Pu for locations SALV (on site) and FCC (off site) from 1982 to 1996. Location FCC represents a typical upwind background location, and SALV represents the perimeter location having the highest annual average for most of this 14-year period. The higher values in the past at SALV may be attributed to historical activities at LLNL; improvements in operational processes in the immediate work area have contributed to the observed downward trend of the data.

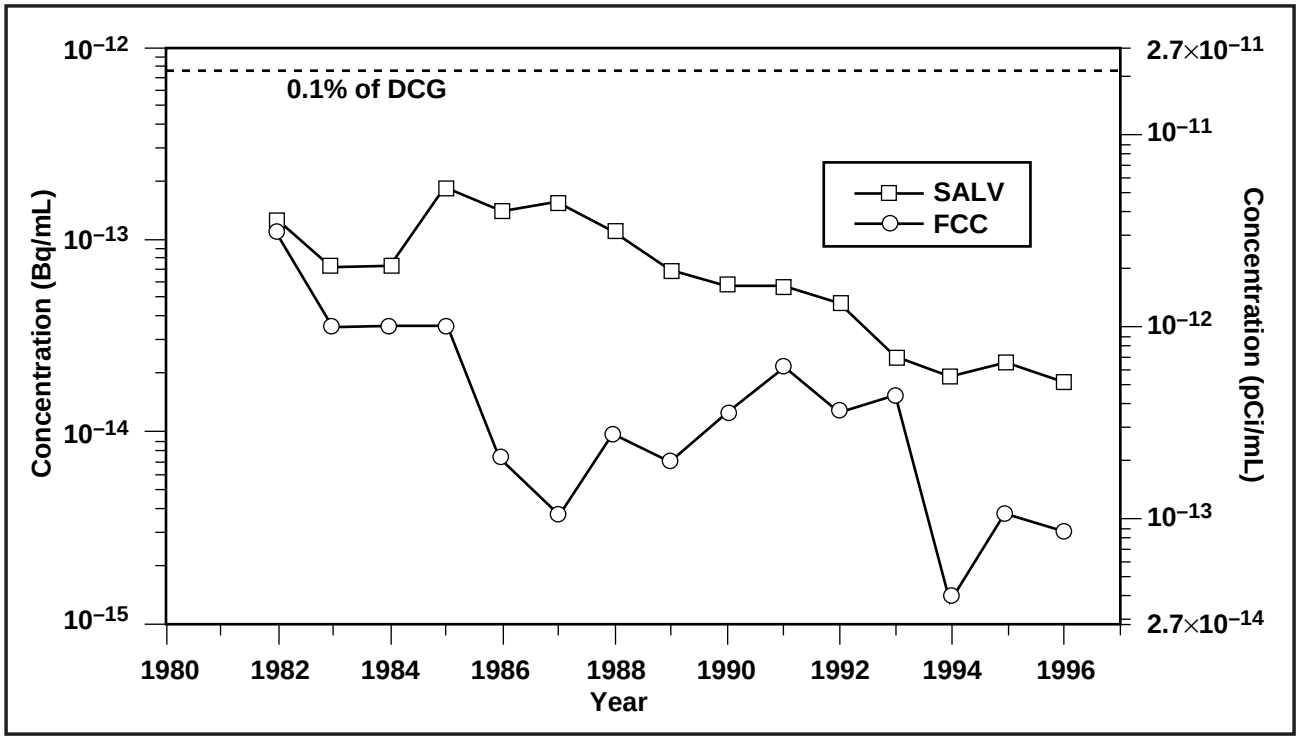

Figure 4-6. Median plutonium concentrations in air particulate samples at two locations, SALV and FCC, 1982 to 1996 (DCG = 7.4×10^{-10} Bq/mL).

In June 1991, two air particulate sampling locations (B531 and CRED) were added as part of a special study to investigate the somewhat elevated levels of plutonium in air and surface soil in the southeast quadrant of the Livermore site (see Chapter 9, Soil and Sediment Monitoring, for general background on this study). These sampling locations are now part of our routine monitoring network and provide data for diffuse source dose assessments. **Table 4-3** shows the median concentrations of airborne ^{239}Pu at these two locations. (See Volume 2, Table 4-8 for monthly data.) The median concentration of 1.3×10^{-13} Bq / mL (3.4×10^{-24} Ci / mL) at location B531 is higher than the median concentration for any of the other air particulate sampling locations but is still only 0.0002 of the DCG.

The median ^{235}U and ^{238}U concentrations in air samples from the Livermore site perimeter are shown in **Table 4-4**. (See Volume 2, Table 4-10 for monthly data.) The maximum measured concentration of ^{238}U is less than 0.0009 of the DCG. All $^{235}U/^{238}U$ median ratios are as expected for naturally occurring uranium; however, monthly data in Volume 2 shows some unexpected $^{235}U/^{238}U$ ratios, indicating other than natural uranium around the Livermore site perimeter. While no significant environmental impact stems from the observed ratios, their cause is not known but they have occurred sporadically in the past.

Table 4-5 shows the median concentrations of tritiated water vapor for the Livermore Valley sampling locations. (See Volume 2, Table 4-12 for biweekly data for each location.) The highest annual median concentration was observed at location ZON7. At approximately 4.3×10^{-8} Bq / mL (1.2×10^{-18} Ci / mL), this concentration represents 0.00001 of the DCG. The highest biweekly concentration was observed in October at ZON7. If it were a yearly average, this concentration, 5.1×10^{-7} Bq / mL (1.4×10^{-17} Ci / mL), would be 0.0001 of the DCG. The 1996 tritium values are generally similar to those reported last year.

Table 4-5 also shows the median concentrations of tritiated water vapor that were observed at the Livermore site perimeter sampling locations. (See Volume 2, Table 4-13 for biweekly data.) The highest annual median concentration was observed at location POOL, which was 2.4×10^{-7} Bq / mL (6.5×10^{-18} Ci / mL), or 0.00007 of the DCG.

Diffuse sources of tritium on the Livermore site are monitored at air tritium sampling locations B331, B292, B514, and B624. **Table 4-5** shows the median concentrations of tritiated water vapor for these sampling locations. (See Volume 2, Table 4-14 for biweekly data.) The highest median concentration was observed at location B624. This concentration was 6.3×10^{-6} Bq / mL (1.7×10^{-16} Ci / mL) and represents 0.002 of the DCG. The highest biweekly tritium concentration, 2.1×10^{-5} Bq / mL (5.7×10^{-16} Ci / mL), was observed in October at location B331. If it were a yearly average, this concentration would represent 0.006 of the DCG.

Table 4-4. Uranium mass in air particulate samples, 1996.

Sampling location[a]	^{238}U[b] (10^{-5} μg/m^3)	^{235}U[c] (10^{-7} μg/m^3)	$^{235}U/^{238}U$[d] (10^{-3})
LLNL perimeter			
CAFE			
Median	4.56	3.29	7.09
Interquartile range	4.79	3.14	0.22
Maximum	9.41	6.56	NA[e]
Median fraction of DCG	1.5×10^{-4}	7.0×10^{-6}	NA
COW			
Median	6.15	4.52	7.25
Interquartile range	13.7	9.77	0.20
Maximum	26.1	18.7	NA
Median fraction of DCG	2.1×10^{-4}	9.6×10^{-6}	NA
MESQ			
Median	3.99	2.77	7.18
Interquartile range	6.36	4.42	0.08
Maximum	14.0	10.1	NA
Median fraction of DCG	1.3×10^{-4}	5.9×10^{-6}	NA
MET			
Median	4.33	2.88	7.16
Interquartile range	4.38	3.13	0.15
Maximum	8.13	5.81	NA
Median fraction of DCG	1.4×10^{-4}	6.1×10^{-6}	NA
SALV			
Median	4.01	2.91	7.16
Interquartile range	5.70	3.97	0.19
Maximum	8.48	6.06	NA
Median fraction of DCG	1.3×10^{-4}	6.2×10^{-6}	NA
VIS			
Median	4.20	2.93	7.17
Interquartile range	3.54	2.55	0.09
Maximum	11.1	7.92	NA
Median fraction of DCG	1.4×10^{-4}	6.2×10^{-6}	NA
Site 300 (composite)			
Median	4.49	2.82	6.42
Interquartile range	5.39	3.51	1.45
Maximum	20.2	4.95	NA
Median fraction of DCG	1.5×10^{-4}	6.0×10^{-6}	NA

a See **Figures 4-1** and **4-3** for sampling locations.

b Derived Concentration Guide = 0.3 μg/m^3 for ^{238}U activity in air.

c Derived Concentration Guide = 0.047 μg/m^3 for ^{235}U activity in air.

d Naturally occurring uranium has a $^{235}U/^{238}U$ ratio of 7.1×10^{-3}.

e NA = Not applicable.

Table 4-5. Tritium in air samples (in 10^{-9} Bq/mL), 1996.

Sampling location[a]	Detection frequency	Median	IQR[b]	Maximum	Median fraction of DCG[c]	Median dose (mSv)[d]
Livermore Valley						
ZON7	24/26	43.3	41.8	514	1.2×10^{-5}	9.3×10^{-6}
ALTA	18/26	<18.5	—[e]	165	$<5.0 \times 10^{-6}$	4.0×10^{-6}
FIRE	13/26	<17.7	—[e]	99.5	$<4.8 \times 10^{-6}$	3.8×10^{-6}
XRDS	14/26	<18.4	—[e]	171	$<5.0 \times 10^{-6}$	4.0×10^{-6}
VET	19/25	24.8	—[e]	205	6.7×10^{-6}	5.3×10^{-6}
HOSP	1/3	<23.4	—[e]	24.3	$<6.3 \times 10^{-6}$	5.0×10^{-6}
Livermore perimeter						
SALV	26/26	81.4	96.3	514	2.2×10^{-5}	1.7×10^{-5}
MESQ	23/26	38.9	53.3	463	1.1×10^{-5}	8.3×10^{-6}
CAFE	26/26	160	126	892	4.3×10^{-5}	3.4×10^{-5}
MET	22/25	43.7	42.3	178	1.2×10^{-5}	9.4×10^{-6}
VIS	26/26	150	63.8	1100	4.0×10^{-5}	3.2×10^{-5}
COW	25/25	86.2	88.4	759	2.3×10^{-5}	1.8×10^{-5}
POOL	23/23	241	223	1480	6.5×10^{-5}	5.2×10^{-5}
Diffuse on-site sources						
B292	25/25	145	119	511	3.9×10^{-5}	3.1×10^{-5}
B331	23/23	729	707	21300	2.0×10^{-4}	1.6×10^{-4}
B514	24/24	392	555	3890	1.1×10^{-4}	8.4×10^{-5}
B624	25/25	6250	5220	19800	1.7×10^{-3}	1.3×10^{-3}

a See **Figures 4-1** and **4-2** for sample locations.

b Interquartile range.

c Derived Concentration Guide = 3.7×10^{-3} Bq/mL (1×10^{-7} μCi/mL).

d 1 mSv = 100 mrem.

e Interquartile range not calculated. See Chapter 13, Quality Assurance.

The B331 location is near the Tritium Facility (Building 331), in which LLNL personnel have reduced operations in recent years and performed significant inventory reduction and cleanup activities. During this process, tritium-contaminated equipment slated for disposal is stored in a waste accumulation area before being sent to Hazardous Waste Management facilities. During 1996, outgassing from such waste processing released an estimated 0.11×10^{12} Bq (3 Ci) of tritium to the atmosphere outside of Building 331.

The B624 location is situated in the Building 612 yard, which is dedicated to hazardous waste, radioactive waste, and mixed-waste management activities. The yard consists of several areas where waste containers that are outgassing tritium are stored outdoors. Probably, as a result of increased legacy waste repackaging at a location within 60 m of the sampler, the median concentration at B624 is almost 7 times higher than 1995.

The B514 sampling location is in a hazardous waste management area where tritium-contaminated waste is treated, and the B292 location is near an underground retention tank that had previously leaked. The 1996 median concentrations at B292 are similar to the median concentrations in 1995.

Beryllium in Air

The median concentrations of airborne beryllium for the Livermore site perimeter sampling locations are shown in **Table 4-6**. (See Volume 2, Table 4-15 for monthly data.) The highest value of 43.4 pg/m^3 occurred in the July composite at location COW. The median concentration for this location is 0.001 of the monthly ambient concentration guide (ACG) of 10,000 pg/m^3 established by the Bay Area Air Quality Management District (BAAQMD) and the Environmental Protection Agency (EPA).

Table 4-6. Beryllium in air particulate samples (in pg/m^3), Livermore site perimeter and Site 300, 1996.

Sampling location[a]	Detection frequency	Median	Interquartile range	Maximum
Livermore perimeter				
SALV	12/12	3.7	6.8	16.2
MESQ	12/12	6.0	8.2	19.5
CAFE	12/12	7.7	5.8	13.6
MET	12/12	8.3	7.9	16.4
VIS	11/12	6.1	4.1	14.8
COW	12/12	10.6	14.9	43.4
Site 300				
EOBS	12/12	3.6	6.4	12.9
ECP	12/12	4.6	4.8	11.1
WCP	12/12	4.8	6.5	10.1
LIN	12/12	5.6	5.3	10.6
GOLF	12/12	4.9	5.5	19.1
TFIR	12/12	7.6	12.6	30.2
NPS	12/12	4.2	4.6	12.1
WOBS	12/12	3.8	5.3	10.9
801E	12/12	6.6	9.1	15.6

[a] See **Figures 4-1** and **4-3** for sampling locations.

Figure 4-7 is a plot of the median beryllium concentration at the Livermore site perimeter from 1974 through 1996. The overall median concentration during this time period was calculated to be 0.002 of the ACG. Unless there is a change in LLNL's operations, it is expected that the beryllium levels will remain unchanged.

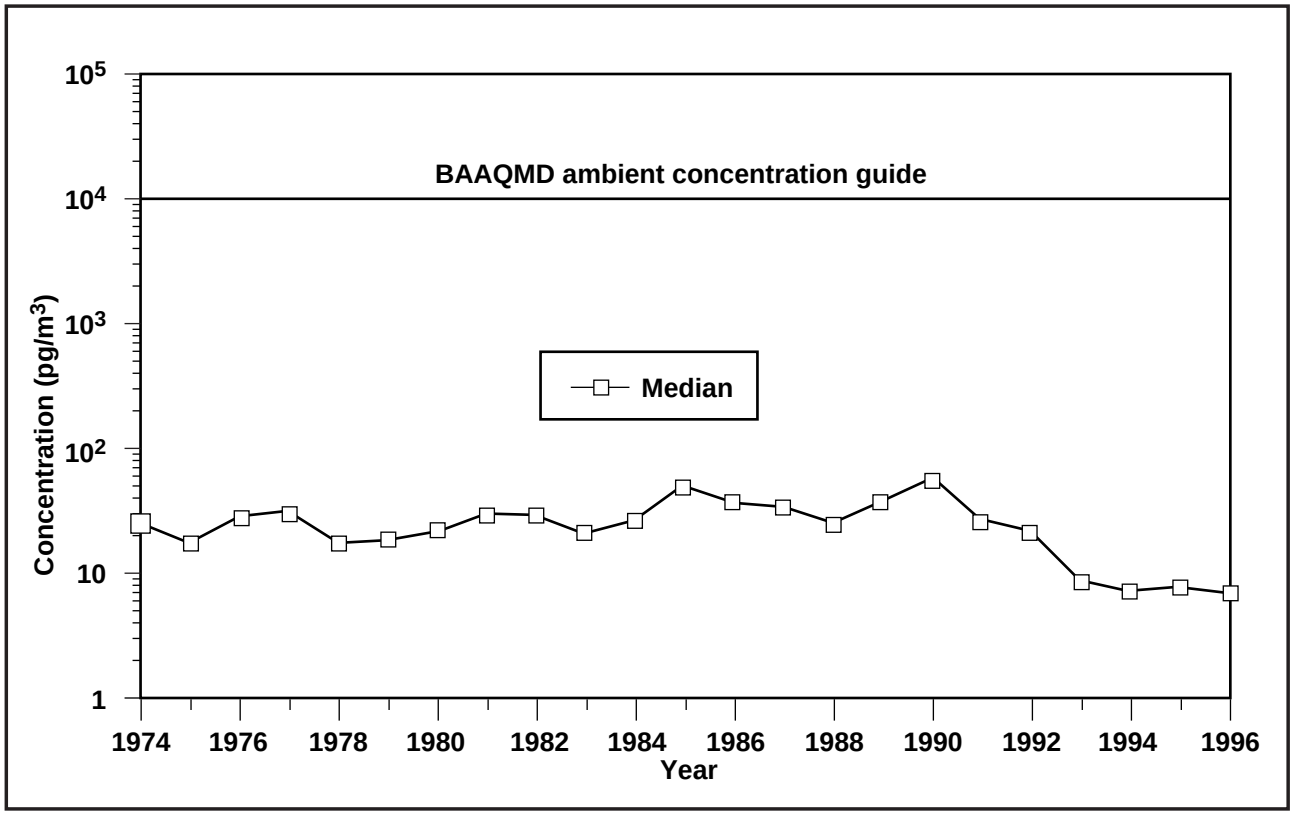

Figure 4-7. Median concentration of beryllium in air particulate samples, Livermore site perimeter, 1975 to 1996.

Site 300

Airborne Radioactivity

Most gross alpha determinations at Site 300 were at or near the analytical limit of detection for the method. **Table 4-1** shows the monthly gross alpha and gross beta median, IQR, and maximum for sampling locations at Site 300. (See Volume 2, Table 4-3 for monthly data.) The monthly median gross alpha and gross beta concentrations are shown in **Figures 4-4** and **4-5**. The Site 300 gross beta results show a similar pattern to those found at the Livermore site. Typical gross alpha activity is 9.8×10^{-12} Bq / mL (2.6×10^{-22} Ci / mL).

Typical gross beta activity is 3.7×10^{-10} Bq / mL (1.0×10^{-20} Ci / mL). The primary sources of observed gross alpha and gross beta activity are naturally occurring radioisotopes of uranium and thorium and their decay products, and any residual fallout from atmospheric weapons testing and the Chernobyl reactor accident (1986).

Table 4-2 lists the annual median activities, IQR, maximum, the fraction of the DCG, as well as the DCG, of gamma-emitting radionuclides in samples from Site 300. (See Volume 2, Table 4-5 for monthly data.) All these radionuclides were measured at concentrations significantly below the DCGs. Of the nuclides tabulated, ^{7}Be, ^{40}K, ^{226}Ra, ^{228}Ra, and ^{228}Th are naturally occurring. The primary source of ^{137}Cs normally is long-term global fallout and resuspension.

Table 4-3 shows the median concentration of ^{239}Pu on air-filter samples collected from Site 300. (See Volume 2, Table 4-9 for monthly data.) The highest concentration of ^{239}Pu was observed in the September composite at a level of 1.0×10^{-14} Bq / mL ($2. \times 10^{-25}$ Ci / mL), or 0.00001 of the DCG. **Table 4-4** shows the median concentration of ^{238}U, ^{235}U, and the $^{235}U / ^{238}U$ ratio on air samples from Site 300. (See Volume 2, Table 4-11 for monthly data.) The highest concentration of ^{238}U was observed in the November composite at a level of 2.0×10^{-4} µg / m^3 (0.0007 of the DCG). The highest concentration of ^{235}U was observed in the September composite at a level of 5.0×10^{-7} µg / m^3 (0.00001 of the DCG). The overall levels were essentially the same as those reported in previous years.

The ratio of ^{235}U to ^{238}U can be used to identify the source of the uranium. Both ^{235}U and ^{238}U occur naturally in the area, but only 0.7% of the naturally occurring uranium is ^{235}U, and the remainder is almost entirely ^{238}U. Because Site 300 operations use depleted uranium that contains very little ^{235}U, it follows that if the ratio remains constant and near 0.7% (within the limit of sampling and analytical error), then the ^{238}U measured is from natural sources. The $^{235}U / ^{238}U$ ratios in April, July, and November are less than expected for natural sources, which indicate some impact from operations at Site 300. The median concentration of ^{238}U for 1996, however, is only 0.0001 of the DCG (DOE Order 5400.5).

Beryllium in Air

The detection frequency, median, IQR, and maximum concentrations of airborne beryllium for the Site 300 sampling locations are shown in **Table 4-6**. (See Volume 2, Table 4-16 for monthly data.) The highest beryllium concentration of 30.2 pg / m^3 occurred in October at location TFIR. The median concentration for this location is 0.0008 of the federal and state ambient concentration limit, which is 10,000 pg / m^3.

Environmental Impact

The environmental impacts from both radioactive and nonradioactive effluents are described in this section.

Radioactive Materials

LLNL operations involving radioactive materials had little impact on radionuclide concentration in ambient air in 1996. Radionuclide concentrations in air at the Livermore site and in the Livermore Valley are well below levels that would cause concern to the environment or public health according to existing regulatory standards.

The diffuse tritium sources at B292, B331, B514, and B624 have a localized effect; the tritium concentrations in October at all the site perimeter and off-site locations were elevated. Higher than average emissions from the tritium facility occurred during late September and early October primarily as a result of glovebox decontamination and decommissioning activities.

The concentrations of radionuclides measured around Site 300 and in the City of Tracy were well below all standards and, except for uranium isotopes, reflect background or naturally occurring levels of these chemicals. (See Chapter 12, Radiological Dose Assessment, for discussion of estimated dose from these data.) The $^{235}U/^{238}U$ ratios in April, July, and November are less than the ratio of naturally occurring concentrations of these isotopes, which suggests that LLNL-introduced depleted uranium is present in air samples from Site 300. These kinds of results can occur when tests using depleted uranium are conducted at Site 300.

Nonradioactive Materials

The concentrations of beryllium at both sites can be attributed to resuspension of surface soil containing naturally occurring beryllium. Local soils contain approximately 1 ppm of beryllium, and the air of the Livermore area and Central Valley typically contains 10 to 100 $\mu g/m^3$ of particulates. Using a value of 50 $\mu g/m^3$ for an average dust load and 1 ppm for beryllium content of dust, a conservative airborne beryllium concentration of 50 pg/m^3 can be predicted. The overall annual medians for the Livermore site and Site 300 are 6.8 pg/m^3 and 4.7 pg/m^3, respectively. These data are lower than predicted, well below standards, and do not indicate the presence of a threat to the environment or public health.